MAJALAH ILMIAH JOURNAL

LPPM Universitas Putra Indonesia YPTK Padang
Jl. Raya Lubuk Begalung, Padang, West Sumatera, Indonesia, Zip Code: 25221
Volume: 32, Issue: 2, Page: 55 - 63, 08/12/2025, e-ISSN: 1412-5854
Available online at website: https://jmi-upiyptk.org/ojs/index.php/jmi/index

Application of Indonesian National Standard 03-2834-2000 in Enhancing Concrete Design Skills for Vocational Construction Teachers

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Abstract

The main challenge identified during the community service program was the limited experience of vocational teachers in effectively utilizing the available concrete design laboratory equipment at the school. This limitation has hindered the effective delivery of practical learning in concrete design, resulting in suboptimal skill development among students and reduced alignment with industry standards. This community service program contributed to enhancing vocational teachers' competence in applying SNI 03-2834-2000 through hands-on training and mentoring on the effective use of concrete design laboratory equipment in SMKN 2 Medan. The community service program was conducted through several stages, including field needs analysis, development of a technical guidance manual, initial socialization, mentoring sessions, and evaluation of the resulting concrete design projects. The results of the community service program showed that the training participants successfully understood the steps of concrete design in accordance with the established standards, as evidenced by an evaluation involving 22 participants which indicated an average achievement score of 89% across the aspects of ease of use, usefulness, attractiveness, and satisfaction. In conclusion, the program effectively strengthened vocational teachers' competence in concrete design based on SNI 03-2834-2000, and its implementation model can be replicated in other vocational schools to enhance the quality of practical construction learning.

Keywords: SNI, Concrete Design, SMK, Vocational Construction Teachers, Vocational School.

1. Introduction

One of the ongoing challenges in vocational education is the weak alignment between the competencies developed in vocational high schools (SMK) and the actual needs of the construction industry. Although the link and match policy has been promoted to bridge this gap, discrepancies persist due to limited industry engagement, outdated instructional methods, and insufficient application of national construction standards. As a result, many vocational graduates are not fully equipped with the practical and technical skills expected in the workplace [1], [2]. This condition highlights the importance of strengthening collaboration between schools and industry through competency-based training and continuous professional development for teachers. By ensuring that vocational education reflects real industrial practices, it becomes possible to produce graduates who are not only technically proficient but also ready to contribute effectively to the construction sector's evolving demands.

To address the persistent gap between vocational education and industrial needs, the Indonesian government introduced the Center of Excellence Vocational School Program (SMK PK) as a strategic initiative to strengthen the link and match between schools and industry. This program emphasizes curriculum alignment with industrial standards, competency-based learning, and the active involvement of industry partners in both teaching and assessment processes. Through SMK PK, vocational schools are encouraged to modernize their facilities, enhance teachers' professional competencies, and implement learning models that simulate real-world industrial practices. In the construction sector, the program plays a crucial role in equipping teachers and students with up-to-date technical knowledge and practical skills, particularly in areas such as concrete mix design, structural testing, and quality control. Ultimately, SMK

PK serves as a catalyst for transforming vocational education into a more responsive, industry-oriented system, capable of producing graduates who meet current and future demands of the construction workforce.

SMKN 2 Medan has undergone a substantial transformation, evolving into one of Indonesia's nationally recognized Centers of Excellence (SMK PK). This transformation was driven by the school's strong commitment to enhancing the quality of vocational education through the integration of industry-based curricula and strategic collaborations with partners from the business and industrial sectors. As part of the SMK PK initiative, SMKN 2 Medan has developed a teaching factory model that immerses students in real workplace environments, enabling them to acquire hands-on experience and competencies aligned with global industry standards [3]. Moreover, the school has strengthened its competency certification system to ensure that graduates possess qualifications acknowledged both nationally and internationally. Government support, coupled with the school's proactive management in improving infrastructure and providing professional training for educators, has been instrumental in sustaining this successful transformation.

In the implementation of the Vocational Center of Excellence (SMK PK) program, one of the recurring challenges involves the procurement of new equipment that cannot be fully utilized by schools. A major issue often encountered is the delay in the procurement and delivery process, resulting in the equipment arriving late and being unavailable when needed for instructional activities [4]. Furthermore, difficulties in installation and operation present additional obstacles. Many newly acquired tools require specific technical knowledge and adequate training for teachers and school technicians to ensure proper usage. Without comprehensive training and hands-on guidance, the equipment remains underutilized and fails to contribute effectively to improving the quality of vocational learning.

A current issue identified at SMKN 2 Medan concerns the limited utilization of newly acquired equipment by teachers during instructional activities. Within the Department of Construction and Building Technology, several units of Compression Testing Machines (CTM) remain unused as shown in Figure 1. Based on observations and interviews with vocational subject teachers, it was found that the main constraint lies in the lack of operational experience and technical proficiency among instructors. The Compression Testing Machine is an essential instrument used to determine the compressive strength of concrete materials, which measures the maximum load that concrete can withstand before failure. This testing process is crucial in civil engineering and construction practices as it provides reliable data on the quality and structural integrity of concrete used in buildings, bridges, and other infrastructure projects. The teachers' unfamiliarity with the operation and maintenance of this testing machine has consequently hindered its integration into the learning process, limiting opportunities for students to gain practical experience aligned with industry standards.

Source: Field Data, 2025

Figure 1. Compression Testing Machines

This community service program was designed to enhance vocational teachers' competence in applying the Indonesian National Standard SNI 03-2834-2000 through practical training and structured mentoring focused on the effective use of concrete design and testing equipment at SMKN 2 Medan. The program aimed to bridge the gap between theoretical understanding and practical application by engaging participants in hands-on activities related to concrete mix design, material testing, and structural evaluation. Furthermore, an assessment of teachers' knowledge was conducted at the end of the program to measure the extent of improvement in their understanding of concrete design principles and laboratory procedures. The results of this evaluation provided valuable insights into the program's effectiveness in strengthening the technical capacity of vocational educators and aligning their instructional practices with industry-based standards.

2. Methods

The implementation method of this community service program comprised five main stages aimed at enhancing the professional competencies of vocational teachers in the field of concrete design. The stages of implementation included: 1) Needs assessment: conducting a comprehensive field analysis to identify the current challenges, competency gaps, and resource limitations faced by vocational teachers in teaching concrete design; 2) Development of concrete technical guidance manual book: producing relevant experimental guidelines aligned with national construction standards; 3) Preliminary dissemination: introducing the results of the instructional design to the participants; 4) Training and mentoring program: providing structured guidance through intensive workshop sessions and post-training mentorship to strengthen participants' understanding in concrete design implementation; 5) Evaluation and reflection: assessing the effectiveness of the developed learning materials and training outcomes through participant feedback, competency tests [5], [6], [7]. The detailed stages of the implementation process are illustrated in Figure 2.

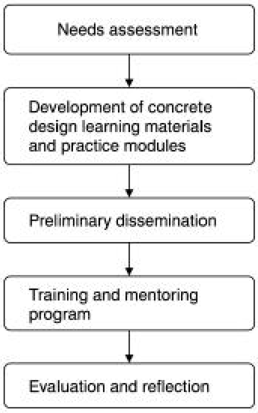


Figure 2. Community Services Method

To evaluate the outcomes of the concrete design training and mentoring activities, data were collected through questionnaires administered to participants after completing the training sessions and developing their respective concrete design learning modules. The evaluation process aimed to measure the perceived effectiveness of the training implementation. The assessment indicators encompassed several dimensions, including: 1) Ease of implementation: reflecting the participants' perception of how accessible and understandable the training materials and methods were; 2) Usefulness: assessing the relevance and applicability of the acquired knowledge and skills in vocational teaching contexts; 3) Engagement: capturing the degree of interest and motivation generated during the training process; 4) Satisfaction: measuring the participants' overall contentment with the training experience and its outcomes. The data processing formula used is as follows:

$$P = \frac{x}{x_i}(100\%) \quad (1)$$

Information:

P	=	Percentage of results of training participants
x	=	Total score answers by trainees
100%	=	Constant
x_i	=	The maximum number of answers in the assessment aspect

The training and mentoring program on concrete design was evaluated for its effectiveness and overall success using the following criteria:

- 75%–100% (Highly Successful) = The concrete design training module introduced to vocational teachers was perceived as highly applicable, beneficial, engaging, and met participants' expectations. Teachers expressed strong satisfaction with the content and delivery, indicating that the community service program achieved its objectives effectively.
- 50%–74% (Moderately Successful) = The concrete design training module was considered somewhat challenging to implement but still valuable and engaging. Participants showed moderate satisfaction with the training outcomes, suggesting that the program required further refinement and follow-up improvement.
- 1%–49% (Unsuccessful) = The concrete design training module was regarded as difficult to apply, of limited usefulness, and lacking in engagement. Participants reported low levels of satisfaction, implying that the program did not achieve the intended impact and required a redesign or alternative approach for future implementation.

3. Results and Discussions

The training and mentoring program on concrete design to enhance vocational teachers' competencies was conducted at State Vocational High School 2 Medan (SMKN 2 Medan), North Sumatera, on August 30, 2025. Prior to the implementation, the community service team carried out a pre-training field visit to conduct a comprehensive needs analysis, identifying gaps in pedagogical and technical competencies related to concrete design instruction. A total of 12 vocational teachers and 10 students participated in the program. The sequence of activities within this community service initiative included the following stages:

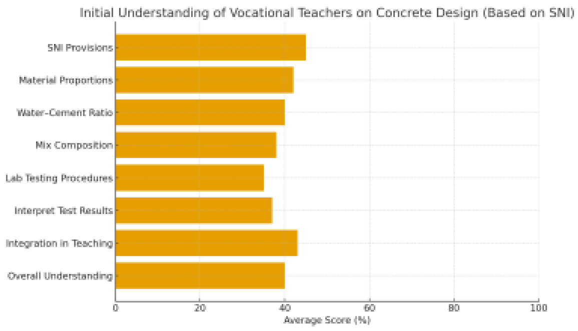
3.1 Needs Assessment

The needs assessment stage was conducted as a foundational step to ensure that the training on concrete design effectively addressed the real challenges faced by vocational teachers. This process involved direct field observations, semi-structured interviews, and questionnaire distribution to collect data on teachers' pedagogical practices, understanding of concrete mix design, and access to relevant laboratory facilities. The detailed stages of the field observations and semi-structured interviews process are illustrated in Figure 3.

Source: Field Data, 2025

Figure 3. Observations and Interviews Activities

The analysis revealed that most teachers possessed theoretical knowledge of construction materials but lacked confidence and experience in applying standardized concrete mix design procedures based on national guidelines. Furthermore, limited exposure to current technological and methodological updates in concrete testing constrained their ability to deliver practice-oriented instruction. Reflectively, this stage provided a critical understanding of the existing competency gap between curriculum expectations and actual teaching practices. The results of the questionnaire are illustrated in Figure 4.



Source: Field Data, 2025

Figure 4. Questionnaire results

The results of the preliminary questionnaire administered to 12 vocational teachers indicate that their understanding of concrete design according to SNI 03-2834-2000 remains limited across both theoretical and practical aspects. The average score of 40% categorizes the teachers' competence level as low, suggesting a substantial gap between curriculum expectations and current instructional practice. Most respondents demonstrated minimal familiarity with standard procedures, particularly in determining mix proportions, water–cement ratios, and laboratory testing methods. This finding reflects the lack of hands-on experience in applying design standards during classroom instruction or in practical workshop settings.

3.2 Development of Concrete Technical Guidance Manual Book

The Concrete Design Technical Guidance Manual serves as a comprehensive instructional resource developed to support vocational teachers in mastering the principles and practices of concrete mix design in accordance with SNI 03-2834-2000. The manual contains systematically organized materials covering the fundamentals of concrete composition, procedures for determining mix proportions, calculation examples, and guidelines for conducting laboratory testing on concrete quality and strength. It also includes visual illustrations, step-by-step instructions for preparing and testing concrete samples, as well as templates for recording and analyzing experimental data. Designed for practical use in vocational school settings, the manual emphasizes both technical accuracy and pedagogical clarity, enabling teachers to integrate standard-based concrete design activities into classroom and workshop learning effectively. The appearance of the technical manual for concrete design training for vocational teachers can be seen in Figure 5.

Source: Field Data, 2025

Figure 5. Technical Book View

The Concrete Design Technical Guidance Manual for Vocational Teachers serves as a comprehensive reference developed to strengthen teachers' competencies in planning, designing, and testing concrete mixtures based on SNI 03-2834-2000 standards. The book systematically presents theoretical concepts, calculation procedures for determining mix proportions, and step-by-step experimental guidelines for testing the quality and strength of concrete. It is equipped with clear illustrations, data recording templates, and contextual examples that make it highly applicable for classroom and workshop use in vocational schools. Designed through a collaborative process involving experts and practitioners, the manual ensures both technical accuracy and pedagogical relevance, bridging the gap between theory and practice in construction education. The book has been validated by academic and industry experts, and the validation results can be seen in Table 1.

Table 1. Expert Validation Results of the Concrete Design Technical Guidance Manual

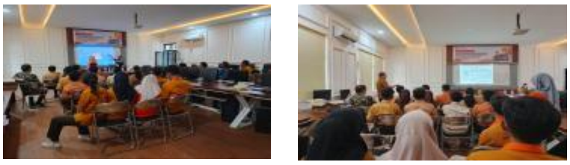
Aspect	Indicator	Score	Categ
Content Relevance	Alignment of material with vocational curriculum and learning objectives	94	Very Valid
Technical Accuracy	Conformity of procedures and calculations with SNI 03-2834-2000 standards	93	Very Valid
Visual Design	Appropriateness of layout, figures, and tables to support understanding	92	Very Valid
Practicality	Feasibility of application in classroom and workshop settings	92	Very Valid

Source: Field Data, 2025

The validation results of the Concrete Design Technical Guidance Manual conducted by expert validators indicated that the developed manual met the required standards of content accuracy, instructional clarity, and technical feasibility. Based on the evaluation sheet, the overall validation score reached 92.5%, which falls into the "very valid" category. Experts from both academic and industry backgrounds assessed several key aspects, including the relevance of the material to vocational education (94%), the conformity of the procedures with SNI 03-2834-2000 standards (93%), the clarity of visual illustrations and layout design (91%), and the practicality for classroom and workshop implementation (92%). The validators also provided constructive feedback emphasizing the inclusion of additional contextual.

3.2 Preliminary dissemination

The preliminary dissemination stage was carried out to introduce and validate the results of the instructional design developed for the Concrete Design Training Program aimed at enhancing vocational teachers' competencies in accordance with SNI 03-2834-2000. This activity took place in a multimedia-equipped classroom at SMKN 2 Medan, involving 12 vocational teachers and 10 students from the Construction and Building Technology Department. The dissemination activities of the technical manual can be seen in Figure 6.



Source: Field Data, 2025

Figure 6. The Dissemination Activities

During the session, the community service team presented the structure, key contents, and application procedures of the Concrete Design Technical Guidance Manual, highlighting the stages of material proportioning, mix design calculations, and standard laboratory testing for concrete strength. Participants were guided through practical examples of mix composition tables, interpretation of compressive strength data, and the integration of these concepts into classroom learning modules. The dissemination also featured interactive discussions and question and answer sessions.

3.4 Training and Mentoring Program

The Training and Mentoring Program was implemented as a structured and interactive learning intervention designed to strengthen vocational teachers' technical competence in concrete design in accordance with SNI 03-2834-2000. This activity integrated both theoretical instruction and practical application through a series of intensive workshop sessions. Participants were guided step-by-step through essential topics, including the classification and weighing of materials (cement, fine and coarse aggregates), determination of mix proportions and calculation of water-cement ratios as seen in Figure 7.

Source: Field Data, 2025

Figure 7. Weighing of Concrete Materials

During the session, the workshop targeted the design of concrete with a compressive strength of 25 MPa, using a mix proportion of 1:1.82:2.96 by weight for cement, sand, and gravel, with a water-cement ratio of 0.48. Through hands-on engagement, participants learned to analyze the influence of material composition and water-cement balance on the resulting concrete quality. After all the material composition is available, the next step is to mix all the materials to form a concrete mixture as shown in Figure 8.

Source: Field Data, 2025

Figure 8. Concrete Mixing

The process begins with accurately measuring each material cement, fine aggregate, coarse aggregate, and water according to the specified mix design proportions. The dry materials are mixed first for approximately 30 seconds until uniform, followed by the gradual addition of water while continuously stirring to achieve a consistent and homogeneous mixture. The optimal mixing duration ranges from 1.5 to 3 minutes, depending on whether mechanical or manual mixing is used. The standard emphasizes that the resulting concrete must have adequate workability to facilitate placement without compromising strength. After mixing, a slump test is immediately conducted to verify the concrete's consistency level before casting as shown in Figure 9.

Source: Field Data, 2025

Figure 9. Slump Test

For normal reinforced concrete, the standard slump value ranges between 60–180 mm, depending on the structure type and pouring method. Mixing that is too long can reduce water content and affect workability, while insufficient mixing may cause uneven distribution of materials. After achieving the required slump value, the concrete is immediately cast and compacted. Following the slump test, the freshly mixed concrete is immediately placed into cylindrical molds as shown in Figure 10.

Source: Field Data, 2025

Figure 10. Concrete Placed Into Cylindrical Molds

The cylindrical molds, typically measuring 150 mm in diameter and 300 mm in height, are cleaned, lubricated, and assembled prior to casting to prevent leakage and ensure easy demolding. The concrete is poured into the molds in three equal layers, with each layer compacted using a tamping rod approximately 25 times to eliminate trapped air and ensure uniform density throughout the specimen. During the compaction process, care is taken to avoid excessive vibration or segregation of materials that could alter the concrete's structural properties. After filling, the surface is leveled and smoothed to maintain a consistent top finish. The specimens are then left undisturbed for approximately 24 hours at ambient temperature before being removed from the molds and transferred to a curing tank for water immersion. This curing process, maintained for 28 days, ensures that the concrete achieves its designed compressive strength and durability in accordance with SNI 03-2834-2000 standards as shown in Figure 11.

Source: Field Data, 2025

Figure 11. Concrete Compression Test

The compressive strength testing of the concrete specimens was conducted after 28 days of curing, following the procedure outlined in SNI 1974:2011 – Method of Testing for Compressive Strength of Cylindrical Concrete Specimens. Five cylindrical specimens, each measuring 150 mm in diameter and 300 mm in height, were tested using a Universal Testing Machine (UTM) to determine their ultimate compressive capacity. The test aimed to verify the achievement of the target concrete strength of 25 MPa, as planned in the mix design developed during the training. The results are summarized in Table 2.

Table 2. The results Concrete Compression Test

Specimen Code	Maximum Load (kN)	Compressive Strength (MPa)	Remarks
C-1	580	24.7	Meets design criteria
C-2	605	25.8	Meets design criteria
C-3	620	26.1	Exceeds design target
C-4	590	25.0	Meets design criteria
C-5	630	26.5	Exceeds design target

Source: Field Data, 2025

The results indicate that all five specimens achieved compressive strength values between 24.7 MPa and 26.5 MPa, with an average strength of 25.6 MPa, slightly above the targeted design value of 25 MPa. This demonstrates that the concrete mix design and implementation procedures were properly executed, resulting in consistent and reliable strength performance [8], [9]. The findings confirm that the training on concrete mix design and testing successfully enhanced participants' understanding and practical skills in accordance with SNI 03-2834-2000 standards, ensuring that vocational teachers are capable of applying quality control practices in real-world construction contexts.

3.5 Evaluation and Reflection

The training program concluded with an evaluation phase designed to assess the overall effectiveness and impact of the concrete mix design training and mentoring activities. This stage aimed to measure the extent to which the learning objectives and competency improvements were achieved among vocational teachers. A total of 22 participants were involved in this evaluation, each completing a structured questionnaire that assessed four key aspects: ease of application, usefulness, attractiveness, and participant satisfaction. The data collected provided valuable insights into the participants' perceptions of the training implementation and its relevance to teaching and industry practices. The detailed outcomes of this evaluation are presented in Table 3.

Table 3. The Evaluation Results

Evaluation Aspect	Maximum Score (x_i)	Average Score (x)
Ease of Application	100	89
Usefulness	100	91
Attractiveness	100	87
Participant Satisfaction	100	89
Amount	**400**	**356**

Source: Field Data, 2025

Percentage

$$P = \frac{x}{x_i}(100\%)$$
$$= \frac{356}{400}(100\%)$$
$$= 0,89\ (100\%)$$
$$P = 89\%$$

The evaluation results demonstrate that the training and mentoring program on concrete design achieved a high level of participant satisfaction across all assessed aspects [10]. The average score of 89% indicates that the training materials, practical sessions, and mentoring strategies were perceived as highly effective and applicable to vocational teaching contexts. This finding confirms that the program successfully enhanced participants' competencies in planning, mixing, and testing concrete according to SNI 03-2834-2000 standards, thereby meeting the intended objectives of the community service initiative.

The results of the concrete compressive strength testing further reinforced the effectiveness of the training and mentoring program in improving vocational teachers' technical competence. This practical outcome validated not only the teachers' understanding of theoretical concepts but also their ability to implement them in laboratory and instructional settings. The successful replication of standardized testing procedures indicated a significant improvement in teachers' analytical and problem-solving skills related to material quality assessment and structural evaluation.

4. Conclusions

The concrete design training and mentoring initiative demonstrated a significant impact on enhancing the technical competence of vocational teachers in applying the principles of SNI 03-2834-2000 for concrete mix design and testing. The systematic implementation comprising stages of needs assessment, instructional material development, guided workshops, and structured evaluation resulted in measurable improvements in participants' understanding of mix proportioning, material handling, and quality control procedures. The evaluation findings, showing an average achievement rate of 89%, affirm that the program effectively increased teachers' mastery of both theoretical and practical aspects of concrete design. Furthermore, this model of professional development provides a replicable and scalable framework that can be adopted by other vocational institutions to elevate the quality and relevance of practical construction learning. By bridging pedagogical training with industry standards, the program contributes to the creation of a more competent and industry-responsive vocational education ecosystem.

Acknowledgements

The authors would like to express their sincere gratitude to the Institute for Research and Community Service (LPPM), Faculty of Engineering, Universitas Negeri Medan, and SMKN 2 Medan for providing essential funding for this program.

Funding Information

This community service activity was funded by the Non-Tax State Revenue (PNBP) of the Institute for Research and Community Service (LPPM), Universitas Negeri Medan, under the 2025 fiscal year. The financial support from LPPM UNIMED played a crucial role in facilitating the implementation, training, and evaluation stages of the concrete design competency enhancement program for vocational teachers.

Author Contributions Statement

All authors have reviewed and approved the final version of the manuscript, confirming their equal commitment to the integrity and quality of the work.

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Naufal Tinov					✓	✓			
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Wahyu Hutria							✓		✓
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Conflict of Interest Statement

Authors state no conflict of interest.

Data Availability

The data that support the findings of this study are available from the corresponding author, [initials, RP], upon reasonable request.

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